

**WE CLAIM:**

1           1. A method for operating a disk drive in a mobile device wherein, immediately after  
2     responding to a disk access command, the disk drive is in a first operating mode that consumes a  
3     relatively high level of power and may transition to a second operating mode that consumes a  
4     relatively low level of power, the method comprising the steps of:

5                 setting first and second time period thresholds, the first time period threshold being less  
6     than the second time period threshold;

7                 providing an adjustable delay time interval that is set to correspond to one of the time  
8     period thresholds, the delay time interval being the time interval for waiting after an end of a  
9     response to a disk access command before transitioning from the first operating mode to the  
10    second operating mode;

11                measuring a demand time interval for each of a plurality of disk access commands,  
12    wherein each demand time interval is defined as a time period between an end of a response to a  
13    last disk access command and an arrival of a next disk access command;

14                setting the delay time interval to be equal to about the first time period threshold if a  
15    majority of a predetermined number of the plurality of demand time intervals falls within a time  
16    period less than the first time period threshold or a time period greater than the second time  
17    period threshold;

18                setting the delay time interval to be equal to about the second time period threshold if a  
19    majority of a predetermined number of the plurality of demand time intervals falls within a time  
20    period between the first time period threshold and the second time period threshold; and

21                transitioning the disk drive from the first operating mode to the second operating mode  
22    after expiration of the delay time interval.

1           2. A method for operating a disk drive as defined in claim 1, wherein transitioning from  
2     the second operating mode to the first operating mode consumes a transition quantity of power,  
3     and an exchange time interval is defined as a time period during which power consumed by  
4     operating in the first power operating mode is about equal to the transition quantity of power.

1           3. A method for operating a disk drive as defined in claim 2, wherein the first time period  
2 threshold is about 0.3% of the exchange time interval, and the second time period threshold is  
3 about 66% of the exchange time interval.

1           4. A method for operating a disk drive as defined in claim 2, wherein the second time  
2 period threshold is less than the exchange time interval.

1           5. A method for operating a disk drive as defined in claim 1, wherein the predetermined  
2 number of the plurality of demand time intervals is 7 and the majority of the predetermined  
3 number of the plurality of demand time intervals for setting the delay time interval is 4.

1           6. A method for operating a disk drive as defined in claim 1, wherein the demand time  
2 intervals comprising the predetermined number of the plurality of demand time intervals are  
3 measured using the most recent disk access commands.

1           7. A method for operating a disk drive in a mobile device wherein, immediately after  
2 responding to a disk access command, the disk drive is in first operating mode that consumes a  
3 relatively high level of power and may transition to a second operating mode that consumes a  
4 relatively low level of power, the method comprising the steps of:

5           setting first, second and third time period thresholds, the first time period threshold being  
6 less than the second time period threshold and the second time period threshold being less than  
7 the third time period threshold;

8           providing an adjustable delay time interval that is set to correspond to one of the time  
9 period thresholds, the delay time interval being the time interval for waiting after an end of a  
10 response to a disk access command before transitioning from the first operating mode to the  
11 second operating mode;

12           measuring a demand time interval for each of a plurality of disk access commands,  
13 wherein each demand time interval is defined as a time period between an end of a response to a  
14 last disk access command and an arrival of a next disk access command;

15           setting the delay time interval to be equal to about the first time period threshold if a

16 majority of a predetermined number of the plurality of demand time intervals falls within a time  
17 period less than the first time period threshold or a time period greater than the third time period  
18 threshold;

19 setting the delay time interval to be equal to about the second time period threshold if a  
20 majority of a predetermined number of the plurality of demand time intervals falls within a time  
21 period between the first time period threshold and the second time period threshold;

22 setting the delay time interval to be equal to about the third time period threshold if a  
23 majority of a predetermined number of the plurality of demand time intervals falls within a time  
24 period between the second time period threshold and the third time period threshold; and

25 transitioning the disk drive from the first operating mode to the second operating mode  
26 after expiration of the delay time interval.

1 8. A method for operating a disk drive as defined in claim 7, wherein transitioning from  
2 the second operating mode to the first operating mode consumes a transition quantity of power,  
3 and an exchange time interval is defined as a time period during which power consumed by  
4 operating in the first power operating mode is about equal to the transition quantity of power.

1 9. A method for operating a disk drive as defined in claim 8, wherein the first time period  
2 threshold is about 0.3% of the exchange time interval, the second time period threshold is about  
3 33% of the exchange time period, and the third time period threshold is about 66% of the  
4 exchange time interval.

1 10. A method for operating a disk drive as defined in claim 8, wherein the third time  
2 period threshold is less than the exchange time interval.

1 11. A method for operating a disk drive as defined in claim 7, wherein the predetermined  
2 number of the plurality demand time intervals is 7 and the majority of the predetermined number  
3 of the plurality demand time intervals for setting the delay time interval is 4.

12. A method for operating a disk drive as defined in claim 7, wherein the demand time intervals comprising the predetermined number of the plurality of demand time intervals are measured using the most recent disk access commands.

13. A mobile device having a disk drive wherein, immediately after responding to a disk access command from the mobile device, the disk drive is in a first operating mode that consumes a relatively high level of power and may transition to a second operating mode that consumes a relatively low level of power, the disk drive comprising:

means for setting first and second time period thresholds, the first time period threshold being less than the second time period threshold;

means for providing an adjustable delay time interval that is set to correspond to one of the time period thresholds, the delay time interval being the time interval for waiting after an end of a response to a disk access command before transitioning from the first operating mode to the second operating mode;

means for measuring a demand time interval for each of a plurality of disk access commands, wherein each demand time interval is defined as a time period between an end of a response to a last disk access command and an arrival of a next disk access command;

means for setting the delay time interval to be equal to about the first time period threshold if a majority of a predetermined number of the plurality of demand time intervals falls within a time period less than the first time period threshold or a time period greater than the second time period threshold, and setting the delay time interval to be equal to about the second time period threshold if a majority of a predetermined number of the plurality of demand time intervals falls within a time period between the first time period threshold and the second time period threshold; and

means for transitioning the disk drive from the first operating mode to the second operating mode after expiration of the delay time interval.

14. A mobile device having a disk drive as defined in claim 13, wherein transitioning from the second operating mode to the first operating mode consumes a transition quantity of

power, and an exchange time interval is defined as a time period during which power consumed by operating in the first power operating mode is about equal to the transition quantity of power.

15. A mobile device having a disk drive as defined in claim 14, wherein the first time period threshold is about 0.3% of the exchange time interval, and the second time period threshold is about 66% of the exchange time interval.

16. A mobile device having a disk drive as defined in claim 14, wherein the second time period threshold is less than the exchange time interval.

17. A mobile device having a disk drive as defined in claim 13, wherein the predetermined number of the plurality of demand time intervals is 7 and the majority of the predetermined number of the plurality of demand time intervals for setting the delay time interval is 4.

18. A mobile device having a disk drive as defined in claim 13, wherein the demand time intervals comprising the predetermined number of the plurality of demand time intervals used by the means for setting the delay time interval are measured using the most recent disk access commands.

19. A mobile device having a disk drive wherein, immediately after responding to a disk access command, the disk drive is in first operating mode that consumes a relatively high level of power and may transition to a second operating mode that consumes a relatively low level of power, the disk drive comprising:

means for setting first, second and third time period thresholds, the first time period threshold being less than the second time period threshold and the second time period threshold being less than the third time period threshold;

means for providing an adjustable delay time interval that is set to correspond to one of the time period thresholds, the delay time interval being the time interval for waiting after an end of a response to a disk access command before transitioning from the first operating mode to the

11 second operating mode;

12 means for measuring a demand time interval for each of a plurality of disk access  
13 commands, wherein each demand time interval is defined as a time period between an end of a  
14 response to a last disk access command and an arrival of a next disk access command;

15 means for setting the delay time interval to be equal to about the first time period  
16 threshold if a majority of a predetermined number of the plurality of demand time intervals falls  
17 within a time period less than the first time period threshold or a time period greater than the  
18 third time period threshold, setting the delay time interval to be equal to about the second time  
19 period threshold if a majority of a predetermined number of the plurality of demand time  
20 intervals falls within a time period between the first time period threshold and the second time  
21 period threshold, and setting the delay time interval to be equal to about the third time period  
22 threshold if a majority of a predetermined number of the plurality of demand time intervals falls  
23 within a time period between the second time period threshold and the third time period  
24 threshold; and

25 means for transitioning the disk drive from the first operating mode to the second  
26 operating mode after expiration of the delay time interval.

1 20. A mobile device having a disk drive as defined in claim 19, wherein transitioning  
2 from the second operating mode to the first operating mode consumes a transition quantity of  
3 power, and an exchange time interval is defined as a time period during which power consumed  
4 by operating in the first power operating mode is about equal to the transition quantity of power.

1 21. A mobile device having a disk drive as defined in claim 20, wherein the first time  
2 period threshold is about 0.3% of the exchange time interval, the second time period threshold is  
3 about 33% of the exchange time period, and the third time period threshold is about 66% of the  
4 exchange time interval.

1 22. A mobile device having a disk drive as defined in claim 20, wherein the third time  
2 period threshold is less than the exchange time interval.

1           23. A mobile device having a disk drive as defined in claim 19, wherein the  
2           predetermined number of the plurality of demand time intervals is 7 and the majority of the  
3           predetermined number of the plurality of demand time intervals for setting the delay time interval  
4           is 4.

1           24. A mobile device having a disk drive as defined in claim 19, wherein the demand time  
2           intervals comprising the predetermined number of the plurality of demand time intervals used by  
3           the means for setting the delay time interval are measured using the most recent disk access  
4           commands.

1           25. A disk drive for use in a mobile device wherein, immediately after responding to a  
2           disk access command from the mobile device, the disk drive is in a first operating mode that  
3           consumes a relatively high level of power and may transition to a second operating mode that  
4           consumes a relatively low level of power, the disk drive comprising:

5                 means for setting first and second time period thresholds, the first time period threshold  
6                 being less than the second time period threshold;

7                 means for providing an adjustable delay time interval that is set to correspond to one of  
8                 the time period thresholds, the delay time interval being the time interval for waiting after an end  
9                 of a response to a disk access command before transitioning from the first operating mode to the  
10                 second operating mode;

11                 means for measuring a demand time interval for each of a plurality of disk access  
12                 commands, wherein each demand time interval is defined as a time period between an end of a  
13                 response to a last disk access command and an arrival of a next disk access command;

14                 means for setting the delay time interval to be equal to about the first time period  
15                 threshold if a majority of a predetermined number of the plurality of demand time intervals falls  
16                 within a time period less than the first time period threshold or a time period greater than the  
17                 second time period threshold, and setting the delay time interval to be equal to about the second  
18                 time period threshold if a majority of a predetermined number of the plurality of demand time  
19                 intervals falls within a time period between the first time period threshold and the second time  
20                 period threshold; and

21 means for transitioning the disk drive from the first operating mode to the second  
22 operating mode after expiration of the delay time interval.

1 26. A disk drive as defined in claim 25, wherein transitioning from the second operating  
2 mode to the first operating mode consumes a transition quantity of power, and an exchange time  
3 interval is defined as a time period during which power consumed by operating in the first power  
4 operating mode is about equal to the transition quantity of power.

1 27. A disk drive as defined in claim 26, wherein the first time period threshold is about  
2 0.3% of the exchange time interval, and the second time period threshold is about 66% of the  
3 exchange time interval.

1 28. A disk drive as defined in claim 26, wherein the second time period threshold is less  
2 than the exchange time interval.

1 29. A disk drive as defined in claim 25, wherein the predetermined number of the  
2 plurality of demand time intervals is 7 and the majority of the predetermined number of the  
3 plurality of demand time intervals for setting the delay time interval is 4.

1 30. A disk drive as defined in claim 25, wherein the demand time intervals comprising  
2 the predetermined number of the plurality of demand time intervals used by the means for setting  
3 the delay time interval are measured using the most recent disk access commands.

1 31. A disk drive for use in a mobile device wherein, immediately after responding to a  
2 disk access command, the disk drive is in first operating mode that consumes a relatively high  
3 level of power and may transition to a second operating mode that consumes a relatively low  
4 level of power, the disk drive comprising:

5 means for setting first, second and third time period thresholds, the first time period  
6 threshold being less than the second time period threshold and the second time period threshold  
7 being less than the third time period threshold;



means for providing an adjustable delay time interval that is set to correspond to one of the time period thresholds, the delay time interval being the time interval for waiting after an end of a response to a disk access command before transitioning from the first operating mode to the second operating mode;

means for measuring a demand time interval for each of a plurality of disk access commands, wherein each demand time interval is defined as a time period between an end of a response to a last disk access command and an arrival of a next disk access command;

means for setting the delay time interval to be equal to about the first time period threshold if a majority of a predetermined number of the plurality of demand time intervals falls within a time period less than the first time period threshold or a time period greater than the third time period threshold, setting the delay time interval to be equal to about the second time period threshold if a majority of a predetermined number of the plurality of demand time intervals falls within a time period between the first time period threshold and the second time period threshold, and setting the delay time interval to be equal to about the third time period threshold if a majority of a predetermined number of the plurality of demand time intervals falls within a time period between the second time period threshold and the third time period threshold; and

means for transitioning the disk drive from the first operating mode to the second operating mode after expiration of the delay time interval.

32. A disk drive as defined in claim 31, wherein transitioning from the second operating mode to the first operating mode consumes a transition quantity of power, and an exchange time interval is defined as a time period during which power consumed by operating in the first power operating mode is about equal to the transition quantity of power.

33. A disk drive as defined in claim 32, wherein the first time period threshold is about 0.3% of the exchange time interval, the second time period threshold is about 33% of the exchange time period, and the third time period threshold is about 66% of the exchange time interval.

1           34. A disk drive as defined in claim 32, wherein the third time period threshold is less  
2 than the exchange time interval.

1           35. A disk drive as defined in claim 31, wherein the predetermined number of the  
2 plurality of demand time intervals is 7 and the majority of the predetermined number of the  
3 plurality of demand time intervals for setting the delay time interval is 4.

1           36. A disk drive as defined in claim 31, wherein the demand time intervals comprising  
2 the predetermined number of the plurality of demand time intervals used by the means for setting  
3 the delay time interval are measured using the most recent disk access commands.

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